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In the course of his interchange with Pearson and Pawlowski & de Vargas, [MacLeod](#) argues more broadly than before against the use of stratigraphic data in phylogenetic analysis, including pointed remarks regarding stratocladistics. I do not contest all of MacLeod's statements, and I am satisfied to let readers sort through others without comment from me. However, a third category of statement does seem to call for response.

[MacLeod](#) claims that I (among others) "miss the practical point of whether currently available stratigraphic data are sufficiently resolved to trust their implied sequences." Evidently, he missed the statement in [my first contribution](#) that I was focusing on the "relevance" of stratigraphic data rather than their "adequacy" in order to respond to what seemed to be the most interesting challenges. If the question of adequacy is now again to be called, we shall return to that, but I must point out that MacLeod's extreme position has apparently allowed him to lose sight of one of the most basic starting points of this debate.

### Scale-dependency

[Andrew Smith](#), in his opening piece, clearly articulated the scale-dependent nature of any evaluation of the adequacy of the stratigraphic record as a source of data for phylogeny. At a coarse enough level of resolution, we are unlikely to go far astray, but just as certainly, there is a finer scale of analysis at which our ability to order events will be unacceptably degraded. Obviously, we must attend to where we are on this scale, but we will gain no new insight by using broadly acknowledged uncertainties at the *finest* levels of stratigraphic resolution to impugn application of stratigraphic data at *all* levels of resolution.

Detailed knowledge of stratigraphy is critical in identifying instances in which the resolution of available stratigraphic data may have been overstated. When the order of certain events appears to be poorly corroborated, the conservative response would be to "lump" them as unresolvable, but this can be done without prejudice to larger scale features of the temporal record. These will be empirical issues, to be resolved independently for forams, felids, and pholads, as studied on either basinal, provincial, or global geographic scales. We welcome cross checking by any of the diverse sources of bio- and lithochronologic information. Susceptibility to testing, independent of phylogenetic analysis, is one of the great strengths of stratigraphic data.

### Hmm, ... so this is garbage?

In reference to the possibility of using stratigraphic data as a test of phylogenetic hypotheses, [MacLeod](#) responds, "garbage in, garbage out". We all understand that garbage is a complex mix of items that are of no use, other items that are of use to someone, but not to us, and still others that might have been useful to us but could not be separated effectively from the rest. Thus, MacLeod is saying that whatever signal may be hiding within stratigraphic data, we cannot separate it from the noise. However, since he does not acknowledge any level of temporal resolution at which we can "trust ... implied sequences", his condemnation effectively extends to all stratigraphic data. If MacLeod grants that uncertainty does not envelope all levels of temporal resolution, then we are back in business again, striving honestly to discern the finest level at which we observe well corroborated patterns.

If MacLeod chooses to stand by his summary ruling that stratigraphic data are "garbage," we need to remember two things. First, stratigraphic data are not the sole province of a group of renegade phylogeneticists; they are the stock and trade of all earth scientists, and we collectively participate in their

reevaluation and refinement. If MacLeod is convinced that such ordering of events is an unresolvable mix of signal and noise, he will need to defend this view to a much broader community.

Secondly, phylogeneticists can make observations bearing on the information content of stratigraphic data by comparing the fit of stratigraphic and morphologic data to phylogenetic hypotheses<sup>1</sup>, as [Chris Paul](#) discussed in his most recent contribution. If stratigraphic data are "garbage" while morphologic data are golden, why do the two agree as well as they do?

### What the future holds

[MacLeod](#) counsels those of us interested in stratocladistics or likelihood methods involving stratigraphic data to prepare for an increasingly marginalized future, as data of interest to us become harder to obtain. Perhaps, but intellectual interest in the principles involved in this controversy will not suffer on this account. In addition, the joint enterprise of refining our understanding of spatiotemporal distributions of organisms will not be set back by broadened discussion of the potential uses of such data. Frankly, I anticipate a future quite different from that which [MacLeod](#) describes. I expect that broader attention to spatiotemporal data will improve, not degrade, our perception of life's history.

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### References

1. Clyde, W.C. & Fisher, D.C. Comparing the fit of stratigraphic and morphologic data in phylogenetic analysis. *Paleobiol.* **23**, 1-19 (1997).